

of the protein particles, and as in the chronic stage of an infection relatively more of the drug prescribed has to be taken up before the effect desired is produced, it became necessary to have a preparation of a non-metal with as large a molecule as possible, so as to enable the protein particles to take up the maximum quantity of the element. For this purpose I introduced intramine, which is an amino-compound of sulphur. Intramine has given results in gonorrhoeal rheumatism and in the chronic stage of gonococcal complications which can be achieved by no other preparation in use at present, and it is many times more powerful than plain colloidal sulphur, just as arseno-benzene is infinitely superior to plain colloidal arsenic. Iodine acts by increasing the sulphur metabolism, owing to the effect it has in converting a substance (mercaptan) formed in the reducing action back into catalytic sulphur. In other words, iodine doubles the action of sulphur, and acts in the reductase reaction as does hydrogen in the oxidase reaction. Owing to the disadvantages of the salts of iodine and to the inefficacy of most of the organic preparations, I introduced colloidal iodine, which can be injected intravenously in the same form as it is taken internally without ever producing symptoms of iodism. There being no specific action in my oxidation and reduction theory of chemotherapy, it will be clear why intramine should be so valuable in the chronic stage of all infections, in the late stages of syphilis, in metallic and other acid intoxications, and applied locally to indolent and chronic sores. In mercurial and arsenical poisoning the combination of colloidal iodine and intramine will cause almost instantaneous amelioration, and it has already saved many lives. The use of intramine in early syphilis rids primary sores of their induration and diminishes the incidence of neuro-recurrences, while in certain forms of late syphilis—glossitis, for instance—intramine will frequently achieve what arseno-benzene has failed to do. The reason why arsenic was chosen for the basis of chemotherapy was because it is one of the easiest metals to work with; it has no specific action, and I am sure if suitable organic compounds of iron and manganese could be produced, no more arsenic would be employed, and we should be saved the hundreds of cases of arsenical poisoning which are occurring, and the enormous increase of nervous syphilis would be reduced to a minimum. The reason why arseno-benzene appears to be so efficacious in syphilis is merely because there are more protein particles formed in this than in any other disease, consequently large amounts of a drug can be taken up, and the oxidizing action of the protein particles can be increased to the maximum. Mercury acts in syphilis in the way it does, first, because of the increased number and size of the protein particles in this disease, and secondly, because in virtue of its high atomic weight it has the properties approaching those of a colloid, and is therefore readily taken up by the protein particles. Any metal having as high an atomic weight or higher will produce the effect on a syphilitic lesion which mercury does; thorium will, for instance. This is probably the reason why the emanations of radium, which have a high atomic weight, are useful in malignant disease. In treatment with metals and non-metals, destroying the patient's resistance, which is so easily done by using too large doses and prescribing too many injections, will give the parasites the upper hand, hence the reason why we are seeing so many cases of syphilis to-day which seem to get worse the more arseno-benzene and mercury is given, and cases which relapse even while under treatment. Unfortunately the disappearance of symptoms does not mean cure of the disease, and all we can really say we do by treatment is to render organisms dormant by increasing the resistance of the host which is harbouring them. Consequently we should in treatment think of the patient and not of the disease, so as to avoid destroying his resistance, which is so easily done by over-treatment. Ideal chemotherapy, then, is to render organisms dormant and keep the host's resistance in a state which will maintain them so.

It is estimated that from October, 1918, to March, 1919, 2 per cent. of the American aborigines died of influenza. In some districts the mortality amounted to 41.2 per 1,000.

A COMMITTEE has been formed to erect a marble monument at Tournai in honour of the eighteenth century ophthalmologist, Michel Brisseau, well known for his work on cataract.

THE EFFECTS OF THE EMOTIONS ON GASTRIC SECRETION AND MOTILITY IN THE HUMAN BEING.

BY

T. IZOD BENNETT, M.D., M.R.C.P.,

ASSISTANT PHYSICIAN, MIDDLESEX HOSPITAL; LATE MEDICAL ASSISTANT AND DEMONSTRATOR OF PHYSIOLOGY, GUY'S HOSPITAL;

AND

J. F. VENABLES, M.B., B.Ch.,

CHIEF ASSISTANT, NEUROLOGICAL DEPARTMENT, GUY'S HOSPITAL.

DURING the past year the fractional method of gastric analysis, first introduced by Rehfuess in the United States, has been employed by one of us (T. I. B.) in conjunction with Dr. J. A. Ryle, in an extensive investigation into the secretion and motility of the gastro-intestinal tract in health and disease. The wide possibilities which the method offers for physiological research were soon apparent, and the present communication is a preliminary report concerning one branch of the inquiry.

That the emotions can moderate digestion to a notable degree has long been recognized; the work of Cannon on frightened animals, and Pavlov's observations on appetite juice are the best known examples. But the present is, we believe, the first occasion on which these effects have been demonstrated on the human subject, and we hope that this communication may lead others to continue an inquiry which, owing to the method employed, allows accurate data to be collected concerning emotions which cannot be evoked in mere animal experiments.

The Method.

The subjects of our experiments were all healthy medical students from the Physiological Department of Guy's Hospital. All experiments were carried out in the morning, beginning at 9.30 o'clock, the subject having taken nothing by the mouth since the previous evening.

In each subject the normal curve was first ascertained; a gruel meal was given, made by boiling two tablespoons of oatmeal in a quart of water until the bulk was reduced to one pint and then filtering through muslin. Samples of the gastric contents were then withdrawn every quarter of an hour through the Rehfuess tube, and the percentage of free and total acid estimated and plotted in a curve. Careful histories were taken from all cases in order to ascertain the most suitable emotive disturbance to be evoked. Each subject was several times interviewed and a light degree of hypnosis produced before the final experiment. The subject's normal curve and emptying rate being established (the latter by finding, by means of iodine, the point at which starch disappeared from the samples of gastric contents), he was told to come up, again without food or drink, on a subsequent morning. On arrival the Rehfuess tube was swallowed and the gruel meal given, the first few specimens were drawn off at the usual times and the subject was then hypnotized. One of us (J. F. V.) then made suggestions appropriate to evoke the required emotion, whilst the other continued to withdraw gastric samples at the regular intervals. Hypnosis was never continued for more than half an hour, nor was it ever pressed to a deep degree. The subjects were always able to remember everything that had happened and had been suggested to them, but were never informed before the experiment as to what emotion was going to be suggested.

It is not possible at the present time to give any precise definition of the hypnotic state; at the depths to which it was carried in our experiments it is very closely analogous to light sleep; the subject has cut off his sensory receptive system from all external stimuli, save those reaching him, via his ears, from the observer. His voluntary musculature receives no efferent impulses from his brain, which for the time being concerns itself solely with the transmission of those reflex and involuntary impulses which result from the suggestions of the observer.

After the hypnosis, on waking up, the subject passed the remainder of the morning in a manner as similar as possible to that of the previous control mornings—that is, he read a newspaper or a textbook, talked with his companions on indifferent topics, or helped with the gastric analyses. Specimens of his gastric contents were still withdrawn every quarter of an hour, until the stomach was empty. In this manner two curves were obtained, the first being the normal curve for the individual, the second a curve showing the effects of the suggested emotion. The emptying rate was also carefully recorded in each case.

Results.

1. *Nausea*.—The subject selected for this experiment was a healthy man of athletic type; for experimental

purposes he had the advantage of possessing a motile stomach which normally empties itself of its gruel meal in three-quarters of an hour. His normal curve being established, he was, after the meal, told that he was feeling exceedingly sick, with no tendency to vomit, but a perpetual intense nausea. On waking from the hypnosis he was able to give a clear account of his sensations and still felt rather sick; but this soon passed off and on the conclusion of the test meal he was able to eat a hearty meal as usual.

Fig. 1 shows the result of this experiment; it will be seen that the usual sharp rise in acidity is completely inhibited, only at the conclusion

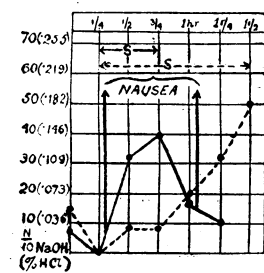


FIG. 1.—Effect of suggested nausea on gastric acidity and motility. Free HCl only plotted. Continuous line = normal curve. Broken line = experimental curve. Rate of emptying, shown thus — S —.

be understood by reference to the law given in the next section.

2. *Hunger*.—Our procedure was similar to that in the previous section, except that intense hunger was suggested. In preliminary experiments we had exhibited attractive food, had cooked eggs, etc., in the presence of subjects undergoing fractional tests, without ever having produced any definite alteration in their acidity curves. Salivation was indeed freely provoked, but even when the mouth was filled with absorbents so as to check the swallowing of saliva, no psychic flow from the stomach could be proved.

The first experiments we made with hunger suggested under hypnosis produced similar negative results, a curve apparently identically the same as the normal curve being produced. We then tried the effect of suggesting the satisfaction of hunger; the subject was told that he was enjoying the sensations experienced after finishing the first hearty meal for a long time. Again our results were negative. We then noticed that although the acid curve

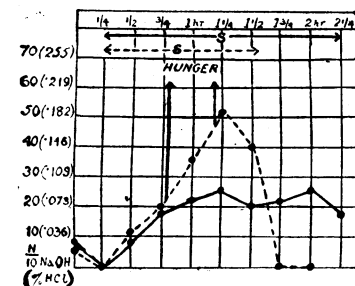


FIG. 2.—Effect of suggested hunger on gastric acidity and motility.

had not been appreciably affected by the hunger suggestion, there was in all these cases a notable quickening of the emptying rate.

We repeated our experiments, making the hunger suggestion at a rather later point, at a moment when the subject's normal curve is beginning to rise; we now got positive results, the most striking of which is shown

in Fig. 2. Now, though the increase in acidity is marked in this case, the increased rapidity of emptying is perhaps still more striking.

It was the consideration of these cases which led us to recognize the following fundamental law:

"In a stomach which is secreting hydrochloric acid, any increase in the rapidity of emptying will by itself determine an increase in the acidity of the contents."

An examination of Fig. 3 will make this law evident. If the stomach be regarded as a reservoir fitted with a tap (the pylorus), and if the oxyntic cells be regarded as a second reservoir pouring acid into the main one, it is evident that if the main contents are escaping rapidly through the pyloric tap, their acidity will more rapidly

increase than if the total bulk of the contents diminished more slowly.

Obvious though this conception be, it has hitherto escaped the attention of all the physiologists and gastrologists to whose work we have had access. This law accounts for our failure to cause an increase in acidity when the hunger suggestion was applied before the acid secretion was at its height. It also accounts for the marked rise of acidity following the removal of the nausea suggestion shown in Fig. 1.

A further interesting question raised by these experiments is that of the mechanism of the normal sensations associated with hunger. Carlson, in his admirable work on *Hunger in Health and Disease*, proves clearly that the sensation of hunger arises normally at the time when the normal peristaltic waves of the empty stomach are changed to a series of much more vigorous contractions. These contractions he regards as the primary factor causing the sensation. Our experiments show the reverse of this; they demonstrate clearly that when the brain is filled with the conception of hunger, vigorous gastric peristalsis is the result.

In our opinion there is nothing contradictory in these results; what could be more logical than that so complicated a reflex should be reversible? The timid traveller sees a robber behind every bush.

3. *Anxiety*.—The effect of rage and fear on the gastric functions has long since been observed in animals; our observations can accordingly claim no originality beyond that of their method. We were lucky in this branch to secure the co-operation of two gentlemen who served with distinction in the Royal Flying Corps during the late war. Both were in good health, and had been discharged fit from the service; but both of them had, during their war experience, had sufficient association with extreme danger to know the meaning of the word anxiety. They had, in fact, "crashed" at various times, though happily without receiving serious permanent injury.

A curve from one of them is here shown (Fig. 4); under hypnosis it was suggested to him that he was again flying, that the weather was foggy, and that he was forced to attempt a landing, although in the vicinity of an enemy town. On recovering from the hypnotic state he said that he had "had the wind up" badly; indeed, he and his companion felt the physical effect of the suggestion for some hours afterwards, although very amused at the experiment. A strong sympathetic inhibition is seen in the curve, with a notable delay in the emptying rate, but the preliminary rise in acidity is less easily explained; can it be that the immediate effect of a hyperadrenalism caused

by anxiety is a quickening of peristalsis, to be followed by arrest?

Such experiments as this last cannot, we feel, be frequently repeated on one subject without risk of establishing a noxious reflex; we have accordingly, with suggestions of this nature, limited our experiments to a single one in the case of any particular subject, taking care at the end of hypnosis to remove the suggestion as fully as possible. This has naturally limited the aggregate number of our results.

Further investigations, dealing with other emotions, are in progress.

In conclusion, we would here like to express our indebtedness to Messrs. Stoker, Currie, Taylor, Greenwood, Mitchell, Moffatt, Powell, Lane, and Wornum, of the physiological department of Guy's Hospital, without whose intelligent and often devoted co-operation this work could not have been attempted.

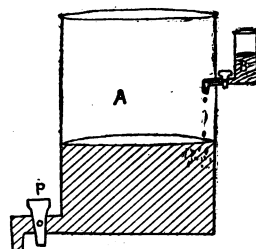


FIG. 3.—Diagram to illustrate the effect of rapid emptying on acidity. A, Stomach; B, Oxyntic cells; P, Pyloric tap.

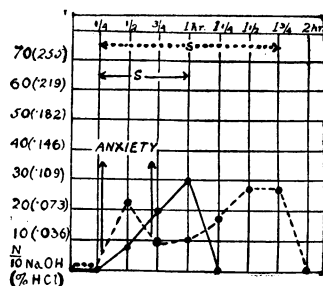


FIG. 4.—Effect of suggested anxiety on gastric acidity and motility.